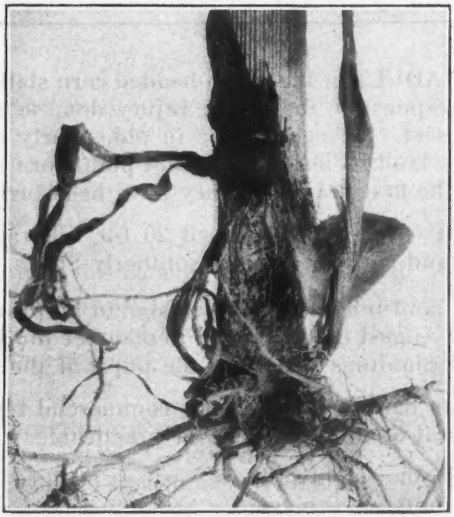
THE ROUGH-HEADED CORN STALK-BEETLE IN THE SOUTHERN STATES AND ITS CONTROL

W. J. PHILLIPS and HENRY FOX

Entomological Assistants
Cereal and Forage Insect Investigations



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FARMERS' BULLETIN 875

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. October, 1917

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THE ADULT of the rough-headed corn stalk-beetle is responsible for all the injury done to corn by this insect. The grubs live in old, poorly drained pasture land. Therefore, do not plant corn on such lands the first year after they have been broken up.

Plant corn early, by April 20 for tidewater Virginia, and earlier for more southerly States.

Sod land intended for corn should be plowed the last of August or the first of September the summer before planting, to destroy the pupæ of the beetles.

Apply barnyard manure or commercial fertilizers in liberal quantities whenever practicable.

Drain thoroughly all low waste or pasture lands in the vicinity of corn crops.

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WITHIN recent years an increasing number of reports of serious damage to the corn crop by a robust black beetle have been received from most of the Southern States. A noteworthy outbreak occurred during the early summer of 1914 in the tidewater section of Virginia.

As very little was known regarding the natural history of this pest, this bulletin has been designed to supply this information. By following the control measures recommended herein it is hoped that the ravages of this pest may be largely overcome in the future.

FIG. 1.—Rough-headed corn stalk-beetle: Adult. Somewhat enlarged.

DESCRIPTION OF THE BEETLE.

The beetle (fig. 1) varies somewhat in size, but usually measures about one-half inch in length. It is a stout, hard-shelled creature, jet black in color. The head and fore part of the body (thorax) appear almost smooth, but the head is in reality finely roughened, and the thorax is covered with numerous minute dots or impressions. The hind body (abdomen) is covered by a pair of hard wing cases which, like the thorax, bear numerous minutely impressed dots or dents and in addition a number of faintly impressed longitudinal lines. The legs are very strong and are provided with a number of coarse spines.

DISTRIBUTION.

The distribution of the beetle, as recorded by the Bureau of Entomology, is shown on the accompanying map (fig. 2). The insect is confined entirely to the Southern States. No records of its occurrence are known north of Virginia, Kentucky, and Kansas. In

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Virginia it appears to be limited to poorly drained lands in the eastern section of the State—that is, in the section locally known as tidewater Virginia.

ECONOMIC IMPORTANCE.

The outbreak in 1914 involved, so far as can be ascertained, about 300 acres of corn (fig. 3) in the tidewater section of Virginia. The injury, as previously stated, was confined to low, poorly drained fields. Some of the infested fields were replanted as many as three times. During the spring of 1917 many reports of injury to corn by the rough-headed corn stalk-beetle were received from Texas, Georgia, Louisiana, Arkansas, and Alabama, the damage caused by the insect in these States having been severe and quite general in character wherever the nature of the soil was such as to sustain the grubs. Field observations show that these severe outbreaks, for reasons as yet imperfectly understood, do not necessarily recur in successive years.

FIG. 2.—Map showing localities where outbreaks of the rough-headed corn stalk-beetle have occurred.

MANNER OF INJURY.

It should be understood clearly that injury to corn by the rough-headed corn stalk-beetle is due entirely to the adult beetle, as the grub does not attack growing plants. The damage to the corn crop takes place only during spring and early summer. The heaviest damage in Virginia appears to occur between May 20 and June 15, although some slight injury may occur as late as the 1st of July. The beetles begin to attack the crop as soon as the plants appear above ground and continue their attacks until the plants are at least knee-high, or even somewhat taller. Full-grown plants, however, apparently are never injured. The beetle bores into the outer wall of the stalk immediately below the surface of the ground, making a large, ragged opening (fig. 4), and destroys the tender growing point or "heart," upon which the black corn beetle appears to feed especially. The destruction of the "heart," or "bud," is indicated quickly above ground by the withering of the central roll of leaves, the other

leaves retaining their freshness for a considerably longer period. The roll of wilted leaves soon dies and can be pulled out with little effort.

FIG. 3.—Field of corn showing severe injury by the rough-headed corn stalk-beetle.

By the time the corn is 3 feet tall the tender growing part of the plant has been pushed above the level of the ground and is reached rarely by the beetles. Consequently, the damage to the plants at this stage is not so severe as in younger stages and the plants recover more readily from the injury.

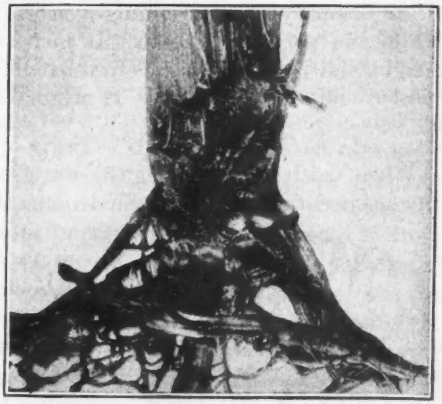

FIG. 4.—Young corn plant, showing characteristic injury by the rough-headed corn stalk-beetle.

SEASONAL HISTORY

The rough-headed corn stalk-beetle, in common with certain other insects, has four stages in its life cycle, namely, the egg, the grub or larva, the pupa or resting stage, and the adult or beetle stage, the last, as stated, being responsible for the injury to growing corn plants.

The essential facts in the life history are briefly as follows: The eggs (fig. 5) are laid in the early summer, chiefly during the month

of June, and are deposited singly or in groups of three or four in the ground wherever the beetles happen to be feeding. The egg hatches in about two weeks into a small white grub or larva (fig. 6) which often is known locally in the South as a "rich-worm." The grubs are common in midsummer and grow very rapidly, reaching full growth in about two months (fig. 7). When mature the grub changes into the pupa (fig. 8), which does not feed and is unable to move about. In about two weeks the skin of the pupa splits, is cast off, and the fully developed beetle (fig. 1) emerges therefrom. The beetles of this new generation appear about the middle of September and soon go into hibernation, there being one generation a year. It is this hibernating or wintering-over generation of beetles that injures corn in the spring.

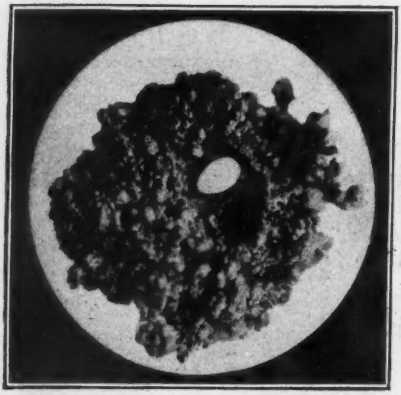

FIG. 5.—Section of earthern cell containing an egg of the rough-headed corn stalk-beetle. Considerably enlarged.

THE EGG.

The egg (fig. 5) when first deposited is about the size of the head of an ordinary pin, resembling a hen's egg in shape, and is pearly white and perfectly smooth. It increases in both weight and bulk and just before hatching it is almost round and about twice its original size.

FIG. 6.—The rough-headed corn stalk-beetle: Young larva, or grub. Enlarged.

THE GRUB.

When newly hatched (fig. 6) the grub is about three-sixteenths of an inch in length. When full grown (fig. 7) it is about 1¼ inches long and about one-fourth of an inch thick. Normally it curls itself up in the form of a crescent, with the head almost touching the tail. The head is brick red and the body dirty white, being distinctly darker near the tail end. The legs are pale brown.

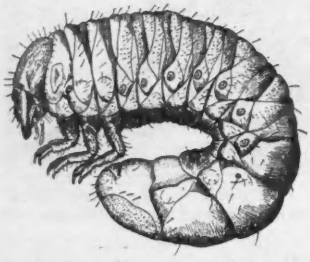

FIG. 7.—The rough-headed corn stalk-beetle: Full-grown larva, or grub. Enlarged.

The grub, so far as known, does not feed upon any of the cultivated crops but lives upon decaying vegetable matter found in or on the ground.

THE PUPA.

The pupa (fig. 8) is about three-fourths of an inch long by three-eighths of an inch broad. When it first becomes a pupa it is white but gradually changes to pale brown. During this stage the insect does not feed and is incapable of locomotion and remains throughout its existence in one place in the soil, anywhere from an inch to several inches below the surface. In this stage the insect is destroyed easily by cultivating the soil and exposing the pupæ to the sun and the attacks of birds, poultry, or hogs.

FIG. 8.—The rough-headed corn stalk-beetle: Pupa. Enlarged.

THE ADULT.

The beetle (see title page and fig. 1) develops within the pupa and when fully formed ruptures the old pupal skin and crawls forth. At first it is almost white, but gradually changes to an intense black. The majority of the beetles emerge during the month of September.

During the fall the beetles spend most of their time in the ground, but on warm days come to the surface to feed. At this time they do not molest corn, but subsist on certain wild grasses which grow abundantly in old pastures and waste areas. With the advent of cold weather the beetles pass into a condition of torpor called hibernation, during which they remain inactive in the ground. With the reappearance of warm weather in late April or early May they become active once more. If food be present, the beetles in most instances remain near the place where they had passed the winter, but when this is lacking they come to the surface and crawl or fly away in search of a more promising spot. About this time the young corn is beginning to appear above ground and the beetles, which either have passed the winter in the field itself or perhaps merely wandered into it from some other field where food was scarce, soon discover and attack the young plants. As the season progresses and the temperature rises the beetles become more active and their appetites are correspondingly more difficult to satisfy. Mating takes place below the surface of the ground and the eggs are laid shortly after. Thus the life cycle starts once more. The old beetles continue active until about the middle of June, after which they disappear quickly.

CONDITIONS FAVORABLE TO OUTBREAKS.

The natural home of the rough-headed corn stalk-beetle consists of low, poorly drained open fields which have not been cultivated for a

long time. These old sod lands are utilized frequently as pastures. Whenever such lands are plowed and immediately planted to corn, the crop may suffer serious injury from the beetles which had been breeding regularly in the old sod. Then, too, in case corn is planted in near-by fields, many of the beetles are likely to spread into these from their ordinary breeding grounds. Such old sod lands support a vegetation in which certain grasses[1] flourish of which the beetles appear to be very fond. In such lands dead and decaying vegetable matter accumulates in considerable quantities, and as the grubs of the rough-headed corn stalk-beetle feed upon such substances it can be understood easily that these old sod lands afford ideal conditions for the multiplication of the pest.

Sometimes the rough-headed corn stalk-beetle appears to be able to breed in temporary sod lands, although the number of beetles produced in such pastures is far below the number which are capable of developing in an equal area of old waste land.

Cornfields appear to be very unfavorable places for the reproduction of the rough-headed corn stalk-beetle. Eggs may be found in abundance in cornfields in which the beetles are feeding, but the number of beetles which develop from these eggs is insignificant compared with the vast numbers that originate in old sod lands.

Thus it becomes evident that one of the most promising methods for controlling the beetles is to avoid maintaining pastures for indefinite periods or allowing any part of the farm to grow up as waste land.

CONTROL MEASURES.

By far the most important means of control is the elimination of all old waste and pasture lands. As has been stated previously, the favorite breeding place—and, in fact, under most conditions the only place where the pest is able to maintain itself in sufficient numbers to become a menace to the corn crops—is in low, poorly drained land that is allowed to remain as waste or as pasture lands for a considerable period of time. Land that is kept in a high state of cultivation and where frequent and systematic rotation of crops is practiced is not a favorable place for the breeding of this beetle. Therefore all low, moist areas should be drained thoroughly and included in the regular system of rotation as practiced for the remainder of the farm. This not only will destroy the main breeding grounds of the insect but will make these lowlands more productive and much easier to cultivate. *Such pasture lands should not be planted to corn the first year*, and as no other cultivated crops are injured by the rough-headed corn stalk-beetle some other crop can be substituted.

[1] *Paspalum* spp.

But since there is a single generation of the beetles a year, the ground may be planted safely to corn the following year.

PASTURING WITH HOGS.

When old waste land can not be drained conveniently and included in the regular rotation, the probabilities of injury resulting from the presence of these breeding grounds may be eliminated largely by pasturing hogs on such land every year, at least during the months of August and September. It is a well-known fact that hogs are very fond of grubs and will root them out industriously and devour them.

EARLY PLANTING.

Since the major portion of the injury to corn occurs during the latter part of May to the middle of June, and since young plants succumb to attack much more easily than larger ones, early planting is recommended where practicable, as a means of avoiding injury. It has been found that corn planted on April 25 at Tappahannock, Va., suffered much less injury from the rough-headed corn stalk-beetle than did plantings made in May. One of the most serious objections to planting so early is that lowlands often are too wet for working in early spring. This can be overcome largely by draining such lands thoroughly.

When planting early, more kernels should be planted to the hill and the plants subsequently thinned if necessary, thereby insuring a better stand.

CHANGE OF ROTATION.

As previously stated, corn should not be planted after sod where there is the prospect of injury from the beetle. Besides the rough-headed corn stalk-beetle, sod worms and cutworms are always a source of danger to corn planted on old sod land. Therefore any system of rotation which obviates the necessity of following sod with corn helps to avoid several serious insect pests.

FERTILIZERS.

The application of barnyard manure or commercial fertilizers is beneficial, because growth is hastened and the corn plants thus enabled more quickly to reach a state where they are less likely to be injured seriously.

HAND PICKING.

Hand picking is at best only a temporary expedient and in most cases very expensive. When a field of growing corn already is infested, however, there is no other hope of relief. Children sometimes may be employed for a small sum to collect and destroy the beetles found in young corn. This work may be done principally when the corn is either being plowed or thinned.

LATE SUMMER PLOWING.

The rough-headed corn stalk-beetle enters the pupa stage during the latter part of August and it is in this stage that the beetle is most easily destroyed, the least disturbance being sufficient to kill the pupæ. For this reason, wherever possible sod lands should be plowed the last week in August or the first week in September for Virginia, but earlier than this for more southerly localities.

SUMMARY OF CONTROL MEASURES.

1. Eliminate all old pastures or waste land, especially low, moist areas, and drain such lands thoroughly.
2. Pasture hogs in waste or pasture lands that can not be conveniently drained and cropped.
3. Plant corn early, say about April 20 for tidewater Virginia, and earlier for more southerly localities.
4. Give liberal applications of barnyard manure or commercial fertilizers whenever practical.
5. Employ children or cheap labor to collect and destroy the beetles when a field first shows injury.
6. Do not allow corn to follow sod if possible to avoid it.
7. Plow sod land in late summer and early fall in order to destroy the pupæ of the rough-headed corn stalk-beetle.

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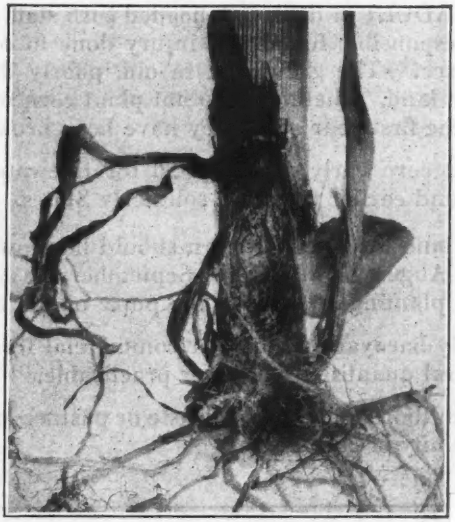

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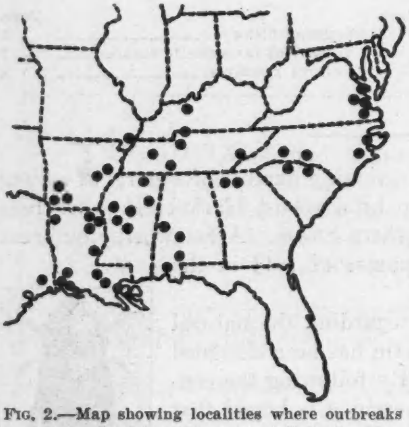

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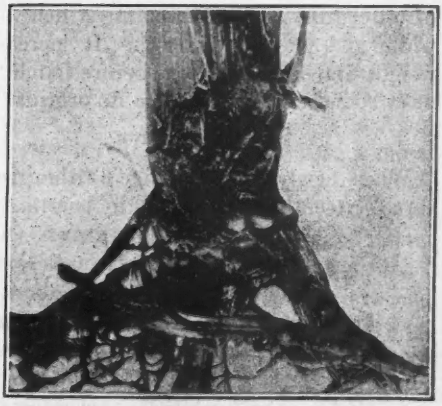

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The essential facts in the life history are briefly as follows: The eggs (fig. 5) are laid in the early summer, chiefly during the month

of June, and are deposited singly or in groups of three or four in the ground wherever the beetles happen to be feeding. The egg hatches in about two weeks into a small white grub or larva (fig. 6) which often is known locally in the South as a "rich-worm." The grubs are common in midsummer and grow very rapidly, reaching full growth in about two months (fig. 7). When mature the grub changes into the pupa (fig. 8), which does not feed and is unable to move about. In about two weeks the skin of the pupa splits, is cast off, and the fully developed beetle (fig. 1) emerges therefrom. The beetles of this new generation appear about the middle of September and soon go into hibernation, there being one generation a year. It is this hibernating or wintering-over generation of beetles that injures corn in the spring.

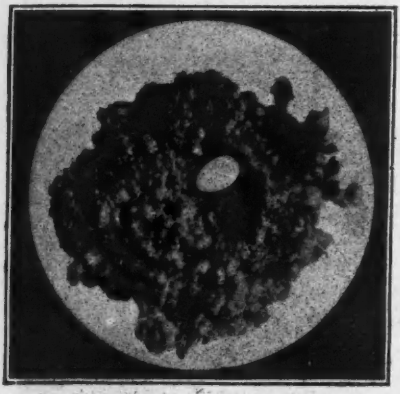

FIG. 5.—Section of earthen cell containing an egg of the rough-headed corn stalk-beetle. Enlarged about three times.

THE EGG.

The egg (fig. 5) when first deposited is about the size of the head of an ordinary pin, resembling a hen's egg in shape, and is pearly white and perfectly smooth. It increases in both weight and bulk and just before hatching it is almost round and about twice its original size.

FIG. 6.—The rough-headed corn stalk-beetle: Young larva, or grub. Enlarged about four times.

THE GRUB.

When newly hatched (fig. 6) the grub is about three-sixteenths of an inch in length. When full grown (fig. 7) it is about 1¼ inches long and about one-fourth of an inch thick. Normally it curls itself up in the form of a crescent, with the head almost touching the tail. The head is brick red and the body dirty white, being distinctly darker near the tail end. The legs are pale brown.

FIG. 7.—The rough-headed corn stalk-beetle: Full-grown larva, or grub. Enlarged nearly two and one-half times.

The grub, so far as known, does not feed upon any of the cultivated crops but lives upon decaying vegetable matter found in or on the ground.

THE PUPA.

The pupa (fig. 8) is about three-fourths of an inch long by three-eighths of an inch broad. When it first becomes a pupa it is white but gradually changes to pale brown. During this stage the insect does not feed and is incapable of locomotion and remains throughout its existence in one place in the soil, anywhere from an inch to several inches below the surface. In this stage the insect is destroyed easily by cultivating the soil and exposing the pupæ to the sun and the attacks of birds, poultry, or hogs.

FIG. 8.—The rough-headed corn stalk-beetle: Pupa. Enlarged about three times.

THE ADULT.

The beetle (see title page and fig. 1) develops within the pupa and when fully formed ruptures the old pupal skin and crawls forth. At first it is almost white, but gradually changes to an intense black. The majority of the beetles emerge during the month of September.

During the fall the beetles spend most of their time in the ground, but on warm days come to the surface to feed. At this time they do not molest corn, but subsist on certain wild grasses which grow abundantly in old pastures and waste areas. With the advent of cold weather the beetles pass into a condition of torpor called hibernation, during which they remain inactive in the ground. With the reappearance of warm weather in late April or early May they become active once more. If food be present, the beetles in most instances remain near the place where they had passed the winter, but when this is lacking they come to the surface and crawl or fly away in search of a more promising spot. About this time the young corn is beginning to appear above ground and the beetles, which either have passed the winter in the field itself or perhaps merely wandered into it from some other field where food was scarce, soon discover and attack the young plants. As the season progresses and the temperature rises the beetles become more active and their appetites are correspondingly more difficult to satisfy. Mating takes place below the surface of the ground and the eggs are laid shortly after. Thus the life cycle starts once more. The old beetles continue active until about the middle of June, after which they disappear quickly.

CONDITIONS FAVORABLE TO OUTBREAKS.

The natural home of the rough-headed corn stalk-beetle consists of low, poorly drained open fields which have not been cultivated for a

long time. These old sod lands are utilized frequently as pastures. Whenever such lands are plowed and immediately planted to corn, the crop may suffer serious injury from the beetles which had been breeding regularly in the old sod. Then, too, in case corn is planted in near-by fields, many of the beetles are likely to spread into these from their ordinary breeding grounds. Such old sod lands support a vegetation in which certain grasses[1] flourish of which the beetles appear to be very fond. In such lands dead and decaying vegetable matter accumulates in considerable quantities, and as the grubs of the rough-headed corn stalk-beetle feed upon such substances it can be understood easily that these old sod lands afford ideal conditions for the multiplication of the pest.

Sometimes the rough-headed corn stalk-beetle appears to be able to breed in temporary sod lands, although the number of beetles produced in such pastures is far below the number which are capable of developing in an equal area of old waste land.

Cornfields appear to be very unfavorable places for the reproduction of the rough-headed corn stalk-beetle. Eggs may be found in abundance in cornfields in which the beetles are feeding, but the number of beetles which develop from these eggs is insignificant compared with the vast numbers that originate in old sod lands.

Thus it becomes evident that one of the most promising methods for controlling the beetles is to avoid maintaining pastures for indefinite periods or allowing any part of the farm to grow up as waste land.

CONTROL MEASURES.

By far the most important means of control is the elimination of all old waste and pasture lands. As has been stated previously, the favorite breeding place—and, in fact, under most conditions the only place where the pest is able to maintain itself in sufficient numbers to become a menace to the corn crops—is in low, poorly drained land that is allowed to remain as waste or as pasture lands for a considerable period of time. Land that is kept in a high state of cultivation and where frequent and systematic rotation of crops is practiced is not a favorable place for the breeding of this beetle. Therefore all low, moist areas should be drained thoroughly and included in the regular system of rotation as practiced for the remainder of the farm. This not only will destroy the main breeding grounds of the insect but will make these lowlands more productive and much easier to cultivate. *Such pasture lands should not be planted to corn the first year*, and as no other cultivated crops are injured by the rough-headed corn stalk-beetle some other crop can be substituted.

[1] *Paspalum* spp.

But since there is a single generation of the beetles a year, the ground may be planted safely to corn the following year.

PASTURING WITH HOGS.

When old waste land can not be drained conveniently and included in the regular rotation, the probabilities of injury resulting from the presence of these breeding grounds may be eliminated largely by pasturing hogs on such land every year, at least during the months of August and September. It is a well-known fact that hogs are very fond of grubs and will root them out industriously and devour them.

EARLY PLANTING.

Since the major portion of the injury to corn occurs during the latter part of May to the middle of June, and since young plants succumb to attack much more easily than larger ones, early planting is recommended where practicable, as a means of avoiding injury. It has been found that corn planted on April 25 at Tappahannock, Va., suffered much less injury from the rough-headed corn stalk-beetle than did plantings made in May. One of the most serious objections to planting so early is that lowlands often are too wet for working in early spring. This can be overcome largely by draining such lands thoroughly.

When planting early, more kernels should be planted to the hill and the plants subsequently thinned if necessary, thereby insuring a better stand.

CHANGE OF ROTATION.

As previously stated, corn should not be planted after sod where there is the prospect of injury from the beetle. Besides the rough-headed corn stalk-beetle, sod worms and cutworms are always a source of danger to corn planted on old sod land. Therefore any system of rotation which obviates the necessity of following sod with corn helps to avoid several serious insect pests.

FERTILIZERS.

The application of barnyard manure or commercial fertilizers is beneficial, because growth is hastened and the corn plants thus enabled more quickly to reach a state where they are less likely to be injured seriously.

HAND PICKING.

Hand picking is at best only a temporary expedient and in most cases very expensive. When a field of growing corn already is infested, however, there is no other hope of relief. Children sometimes may be employed for a small sum to collect and destroy the beetles found in young corn. This work may be done principally when the corn is either being plowed or thinned.

LATE SUMMER PLOWING.

The rough-headed corn stalk-beetle enters the pupa stage during the latter part of August and it is in this stage that the beetle is most easily destroyed, the least disturbance being sufficient to kill the pupæ. For this reason, wherever possible sod lands should be plowed the last week in August or the first week in September for Virginia, but earlier than this for more southerly localities.

SUMMARY OF CONTROL MEASURES.

1. Eliminate all old pastures or waste land, especially low, moist areas, and drain such lands thoroughly.
2. Pasture hogs in waste or pasture lands that can not be conveniently drained and cropped.
3. Plant corn early, say about April 20 for tidewater Virginia, and earlier for more southerly localities.
4. Give liberal applications of barnyard manure or commercial fertilizers whenever practical.
5. Employ children or cheap labor to collect and destroy the beetles when a field first shows injury.
6. Do not allow corn to follow sod if possible to avoid it.
7. Plow sod land in late summer and early fall in order to destroy the pupæ of the rough-headed corn stalk-beetle.

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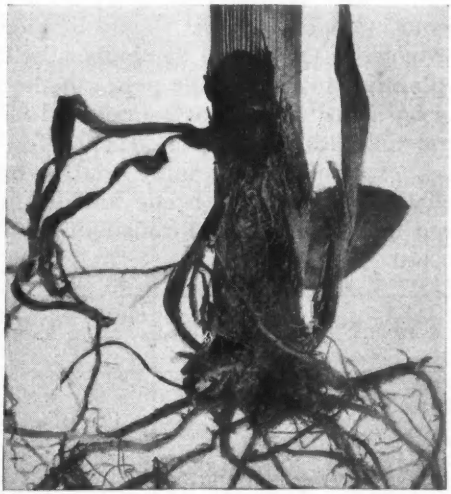
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 875 rev. June 1933

THE ROUGH-HEADED CORN STALK BEETLE IN THE SOUTHERN STATES AND ITS CONTROL



THE ADULT of the rough-headed corn stalk beetle is responsible for all the injury done to corn by this insect. The grubs live in old, poorly drained pasture land. Therefore, do not plant corn on such lands the first year after they have been broken up.

Drain and thoroughly cultivate all low waste or pasture lands in the vicinity of corn crops.

Plant corn early, by April 20 for tidewater Virginia, and earlier for more southerly States.

Sod land intended for corn should be plowed the last of August or the first of September the summer before planting, to destroy the pupae of the beetles.

Apply barnyard manure or commercial fertilizers in liberal quantities whenever practicable.

Besides explaining fully these control measures this bulletin describes the beetle and its injurious work and tells how it lives throughout the year.

Washington, D. C. Issued October, 1917, revised June 1933

THE ROUGH-HEADED CORN STALK BEETLE[1] IN THE SOUTHERN STATES AND ITS CONTROL

By W. J. PHILLIPS, *Senior Entomologist, Division of Cereal and Forage Insects,* and HENRY FOX, *Associate Entomologist, Division of Japanese and Asiatic Beetles, Bureau of Entomology*[2]

THE INSECT discussed in this bulletin as the rough-headed corn stalk beetle does serious damage to corn in many parts of the Southeastern States. It has long been unfavorably known in the Gulf States as the sugarcane beetle, and in Louisiana is recorded frequently as destructive to growing rice.

Only the adult beetle is implicated in any of the depredations, and the information in this bulletin is intended mainly to facilitate its control for the protection of the corn crop.

FIGURE 1.—Rough-headed corn stalk beetle: Adult. About twice natural size

DESCRIPTION OF THE BEETLE

The beetle (fig. 1) varies somewhat in size, but usually measures about one-half inch in length. It is a stout, hard-shelled, jet black creature. The head and fore part of the body (thorax) appear almost smooth, but the head is in reality finely roughened, and the thorax is covered with numerous minute dots or impressions. The hind body (abdomen) is covered by a pair of hard wing cases which, like the thorax, bear numerous minutely impressed dots or dents and in addition a number of faintly impressed longitudinal lines. The legs are very strong and are provided with a number of coarse spines.

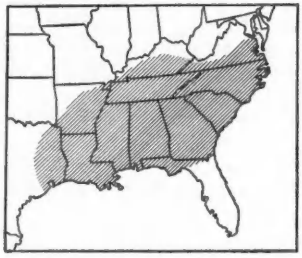


FIGURE 2.—Map showing area in which outbreaks of the rough-headed corn stalk beetle have occurred

DISTRIBUTION AND IMPORTANCE

The insect is found only in the Southern States. (Fig. 2.) There is no record of its occurrence north of Virginia, Kentucky, and Kansas. In Virginia it appears to be limited to poorly drained lands in the eastern part of the State known locally as tidewater Virginia, where, because of its attacks some of the infested fields have been replanted as many as three times in one season. Many reports of injury to corn by the rough-headed corn stalk beetle have been received from Texas, Georgia, Louisiana, Arkansas, and Alabama. The damage

[1] (*Ligyrus*) *Euetheola rugiceps* Lec.; order Coleoptera, family Scarabaeidae.
[2] This revision has been made by the senior author.

caused by the insect in these States has been severe and general wherever the nature of the soil was such as to sustain the grubs. There are numerous records of injury also from Mississippi and Tennessee that show that the stalk beetle is an active pest. Field observations show that severe outbreaks, for reasons as yet imperfectly understood, do not necessarily recur in successive years.

MANNER OF INJURY

Injury to corn by the rough-headed corn stalk beetle is done entirely by the adult beetle, as the grub has never been found attacking growing plants. The damage takes place only during spring and early summer. In Virginia the heaviest damage appears to occur between May 20 and June 15, although some slight injury may occur as late as the 1st of July. The beetles begin to attack the crop as soon as the plants appear aboveground and continue their attacks until the plants are at least knee-high, or even somewhat taller. Full-grown plants, however, apparently are never injured. The beetle bores into the outer wall of the stalk immediately below the surface of the ground, making a large ragged opening (fig. 3), and destroys the tender growing point or "heart," upon which the beetle appears to feed especially. The destruction of the heart, or bud, is indicated quickly aboveground by the withering of the central roll of leaves, the other leaves retaining their freshness for a considerably longer period. The roll of wilted leaves soon dies and can be pulled out with little effort.

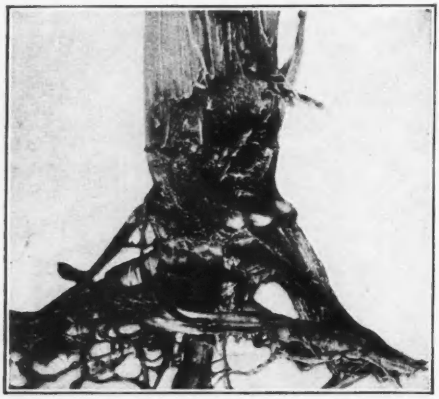


FIGURE 3.—Young corn plant, showing characteristic injury by the rough-headed corn stalk beetle

By the time the corn is 3 feet tall the tender growing part of the plant has been pushed above the level of the ground and is rarely reached by the beetles. Consequently, the damage to the plants is not so severe at this stage as at younger stages and the plants recover more readily from the injury.

SEASONAL HISTORY

The rough-headed corn stalk beetle, in common with certain other insects, has four stages in its life cycle, namely, the egg, the grub or larva, the pupa or resting stage, and the adult or beetle stage, the last, as stated, being responsible for the injury to growing corn plants.

The essential facts in the life history are: The eggs (fig. 4) are laid in the early summer, chiefly during June, and are deposited singly or in groups of three or four in the ground wherever the

beetles happen to be feeding. The egg hatches in about two weeks into a small white grub or larva (fig. 5) which often is known locally in the South as a "rich-worm." The grubs are common in mid-summer and grow very rapidly, reaching full growth in about two months. (Fig. 6.) When mature the grub changes into the pupa (fig. 7), which does not feed and is unable to move about. In about two weeks the skin of the pupa splits, and is cast off, and the fully developed beetle (fig. 1) emerges therefrom. The beetles of this new generation appear about the middle of September and soon go into hibernation, there being one generation a year. It is this hibernating or wintering-over generation of beetles that injures corn in the spring.

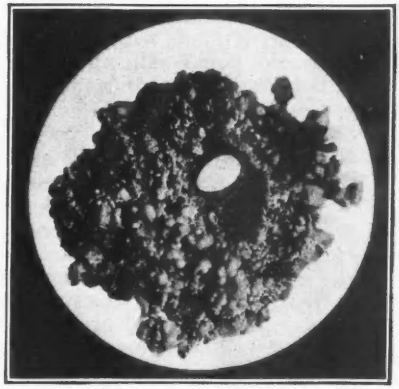


FIGURE 4.—Section of earthen cell containing an egg of the rough-headed corn stalk beetle. Enlarged about 3 diameters

THE EGG

The egg (fig. 4) when first deposited is about the size of the head of an ordinary pin, resembling a hen's egg in shape, and is pearly white and perfectly smooth. It increases in both weight and bulk and just before hatching it is almost round and about twice its original size.

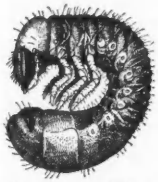


FIGURE 5.—The rough-headed corn stalk beetle: Young larva, or grub. Enlarged about 15 diameters

THE GRUB

When newly hatched (fig. 5) the grub is about three-sixteenths inch in length. When full grown (fig. 6) it is about 1¼ inches long and about one-fourth inch thick. Normally it curls itself up in the form of a crescent, with the head almost touching the tail. The head is brick red and the body dirty white, being distinctly darker near the tail end. The legs are pale brown.

The grub does not appear to feed upon any cultivated crop but lives largely upon decaying vegetable matter found in or on the ground.

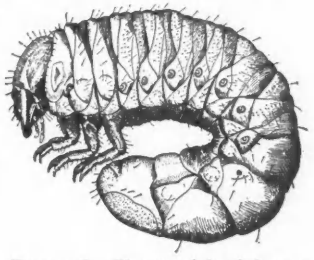


FIGURE 6.—The rough-headed corn stalk beetle: Full-grown larva, or grub. Enlarged about 2¼ diameters

THE PUPA

The pupa (fig. 7) is about three-fourths inch long by three-eighths inch broad. When it first becomes a pupa it is white but gradually changes to pale brown. During this stage the insect does not feed and remains in one place in the soil, anywhere from 1 to several

inches below the surface. In this stage the insect is destroyed easily by cultivating the soil and exposing the pupae to the sun and the attacks of birds, poultry, or hogs.

THE ADULT

The beetle develops within the pupa and when fully formed ruptures the old pupal skin and crawls forth. At first it is almost white, but gradually changes to an intense black. The majority of the beetles emerge in September.

During the fall the beetles spend most of their time in the ground, but on warm days come to the surface to feed. At this time they do not molest corn, but subsist on certain wild grasses which grow abundantly in old pastures and waste areas. With the advent of cold weather the beetles go into a condition of torpor and pass the winter in hibernation, remaining inactive in the ground. With the reappearance of warm weather in late April or early May they become active once more. If food is present, the beetles usually remain near the place where they passed the winter, but when it is lacking they come to the surface and crawl or fly away in search of a more promising spot. About this time the young corn is beginning to appear aboveground and the beetles, which have passed the winter in the field itself or perhaps have merely wandered into it from some other field where food was scarce, soon discover and attack the young plants. As the season progresses and the temperature rises the beetles become more active, and their appetites are correspondingly more difficult to satisfy. Mating takes place below the surface of the ground, and the eggs are laid shortly after. Thus the life cycle starts once more. The old beetles continue active until about the middle of June, after which they rapidly decrease in numbers, becoming scarce within a month and disappearing entirely about August 1.

FIGURE 7.—The rough-headed corn stalk beetle: Pupa. Enlarged about three times

CONDITIONS FAVORABLE TO OUTBREAKS

The natural home of the rough-headed corn stalk beetle is in low, poorly drained open fields which have not been cultivated for a long time. These old sod lands are frequently used as pastures. Whenever they are plowed and immediately planted to corn, or when corn is planted near by, the crop may suffer serious injury from the beetles that had been breeding regularly in the old sod. Such old sod lands support a vegetation in which flourish certain grasses [3] of which the beetles appear to be very fond. In such lands dead and decaying vegetable matter accumulates in considerable quantities, and as the grubs of the rough-headed corn stalk beetle feed upon such substances

[3] *Paspalum* spp.

it can easily be understood that these old sod lands afford ideal conditions for the multiplication of the pest.

Sometimes the rough-headed corn stalk beetle can develop in small numbers in temporary sod lands and cornfields, and though eggs may be found in abundance in cornfields in which the beetles are feeding, such places, as compared with old sod land, are very unfavorable for reproduction.

Therefore one of the most promising methods for controlling the beetles is not to maintain pastures for indefinite periods or to allow any part of the farm to grow up as waste land.

CONTROL MEASURES

By far the most important means of control is the elimination of all old waste and pasture lands. As has been stated, the favorite breeding place—and, in fact, under most conditions the only place where the pest is able to maintain itself in sufficient numbers to become a menace to the corn crops—is in low, poorly drained land that is allowed to remain as waste or as pasture lands for a considerable time. Land that is kept in a high state of cultivation and on which frequent and systematic rotation of crops is practiced is not a favorable place for the breeding of this beetle. Therefore all low, moist areas should be drained thoroughly and included in the regular system of rotation. This not only will destroy the main breeding grounds of the insect but will make these lowlands more productive and much easier to cultivate. Such pasture lands should not be planted to corn the first year. As the beetle injures no other cultivated crops, except cane and rice, some other crop can be substituted. But since there is only one generation of the beetles a year, the ground may be safely planted to corn the following year.

PASTURING WITH HOGS

When old waste land can not be conveniently drained and included in the regular rotation, the probabilities of injury resulting from their existence as breeding grounds may be eliminated largely by pasturing hogs on such land every year, at least during August and September. It is well known that hogs are very fond of grubs and will root them out industriously and devour them.

EARLY PLANTING

Since most of the injury to corn occurs from the latter part of May to the middle of June, and since young plants succumb to attack much more easily than larger ones, early planting where practicable is recommended as a means of avoiding injury. It has been found that corn planted on April 25 at Tappahannock, Va., suffered much less injury from the rough-headed corn stalk beetle than did plantings made in May. One of the most serious objections to planting so early is that lowlands often are too wet for working in early spring. This can be overcome largely by draining such lands thoroughly.

When planting early, more kernels should be planted to the hill and the plants subsequently thinned if necessary, thereby insuring a better stand.

CHANGE OF ROTATION

As previously stated, corn should not be planted after sod if there is the prospect of injury from the beetle. Besides the rough-headed corn stalk beetle, sod webworms and cutworms are always a source of danger to corn planted on old sod land. Therefore any system of rotation that obviates the necessity of following sod with corn helps to avoid several serious insect pests.

FERTILIZERS

The application of barnyard manure or commercial fertilizers is beneficial, because it hastens growth and enables the corn plants more quickly to reach a stage in which they are less likely to be injured seriously.

HAND PICKING

Hand picking the beetles is at best only a temporary expedient and in most cases very expensive. When a field of growing corn already is infested, however, there is no other hope of relief. Children sometimes may be employed for a small sum to collect and destroy the beetles found in young corn. This work may be done principally when the corn is being either plowed or thinned.

LATE SUMMER PLOWING

The rough-headed corn stalk beetle enters the pupa stage during the latter part of August and it is in this stage that the beetle is most easily destroyed, the least disturbance being sufficient to kill the pupae. For this reason, wherever possible, sod lands should be plowed the last week in August or the first week in September for Virginia, and earlier for more southerly localities.

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